Ideas for problem assignments

1) Compare beam power levels for 7 GeV 100 mA storage ring vs. 7 GeV 100 mA ERL

2) Calculate emitted photon power, power densities for 7 GeV 100 mA electron beam
- Bending magnet source given B and / or rho, in Watts, Watts / milliradian
- Undulator A, given peak on-axis field and/or k value, No. of periods, in Watts, Watts / mrad^2, Watts / mm^2 @ 50 meters from the source point.
- Wiggler

3) Compute exact expression for $\Delta x'$ for thick hard-edge dipole magnet, compare to

$$\Delta x' = \frac{1}{B\rho}\int B(s)\,ds = \frac{Bs}{B\rho} = \frac{s}{\rho}$$

$x^2 + (y-\rho)^2 = \rho^2$
$x = \rho \sin(s/\rho)$
$y = \rho (1-\cos(s/\rho))$
-> $dy/dx = -x / (y-\rho) = \tan(s/\rho)$
Difference = $\tan(s/\rho) - s/\rho = (s / \rho)^3 + O[(s/\rho)^5]$

4a) Given a plot of the orbit distortion caused by a single corrector, find 1) the integer part of the tune, and 2) whether the fractional part of the tune is > or < 0.5.

4a) Draw electron-beam phase space representation of three-bump, derive amplitude at center corrector as a function of first kick angle, $\Delta\psi_{12}$, $\Delta\psi_{23}$, β_1, β_2 , β_3 . Derive ratio of kick angles $\Delta x'_1$, $\Delta x'_2$, $\Delta x'_3$ as function of the same 5 quantities.

4b) Construct two overlapping 3-bumps to produce symmetric and antisymmetric four bump - constrain $\beta_1 = \beta_4$, $\beta_2 = \beta_3$, $\Delta\psi_{12} = \Delta\psi_{34}$. Hint $\Delta x'_1 = \Delta x'_4$, $\Delta x'_2 = \Delta x'_3$ for symmetric bump, $\Delta x'_1 = -\Delta x'_4$, $\Delta x'_2 = -\Delta x'_3$ for antisymmetric bump. Solve for Δx at symmetry point for symmetric bump, $\Delta x'$ at symmetry point for antisymmetric bump. Do numerical example, compare original APS injection bump with small phase advance to actual implementation, using 3π - bump - get ratio of corrector strengths between the two cases.

5) Explain how x = sqrt(beta) cos (phi) is the equation for a straight line, given quadratic dependence of beta on s.

6) From Nick:

Determing properties for simple damping of a hom-induced instability in an ERL.